Amendments to the Claims

Please replace the prior listing of claims with the following listing of claims.

Listing of Claims

1.- 11 (Cancelled)

12. (Currently amended) A heave compensation apparatus for a winch or crane system, wherein the winch or crane system is provided on a vessel, the winch or crane system including a lift wire for attachment to a load, the apparatus comprising:
a load motion measurement device coupled to and provided on the load for measuring the motion of the load, and a control device capable of receiving an output from the load motion measurement device indicative of the movement of the load, ~~and~~ wherein the control device ~~controlling~~controls the winch or crane system ~~according to the movement of the load, so as~~in response to said output to pay out or recover lift wire from a drum located on the vessel as required to stabilise the load.

13. (Currently amended) A heave compensation apparatus according to claim 12, wherein ~~when the winch or crane system is provided on a vessel,~~ the apparatus includes a vessel motion measurement device for measuring the motion of the vessel, and the control device is capable of receiving an output from the vessel motion measurement device and controlling the winch or crane system according to the movement of the vessel.

14. (Previously presented) A heave compensation apparatus according to claim 12, further comprising a lift wire distance measurement device which measures the length of lift wire that has been paid out.

15. (Previously presented) A heave compensation apparatus according to claim 12, further comprising a lift wire tension measuring device for measuring the tension in the lift wire.

16. (Currently amended) A method of heave compensation for a winch or crane system, wherein the winch or crane system is provided on a vessel, the winch or crane system including a lift wire, the method comprising the steps of:
coupling a load motion measurement device to the load and providing it on the load;
using a control device to ~~monitoring~~monitor the data output by the load motion measurement device indicative of the movement of ~~a~~the load suspended by the lift wire; and
adjusting the pay out or recovery of the lift wire from a drum located on the vessel to compensate for the movement of the load.

17. (Cancelled)

18. (Currently amended) A method according to claim 16,~~of heave compensation for a winch or crane system including a lift wire, the method comprising the steps of:~~ further comprising
measuring the length of lift wire that has been paid out and
inputting data indicative of the said length into the control device~~adjusting the pay out or recovery of the lift wire to stabilise the load~~.

19. (Currently amended) A heave compensation apparatus for a winch or crane system, the winch or crane system being provided on a vessel and including a lift wire for attachment to a load, the apparatus comprising:
a) a vessel motion measurement device for measuring the motion of the vessel;
b) a lift wire tension measuring device for measuring the tension in the lift wire;
c) a lift wire distance measurement device which measures the length of lift wire that has been paid out; and
d) a lift wire resonance calculation means comprising a computational means into which an operator can input data concerning the elasticity characteristics of the lift wire, wherein the computational means takes data output from the lift wire distance measurement device and calculates the elasticity of the lift wire from the length of wire paid out, by reference to its elasticity characteristics;

~~and~~ the apparatus further comprising a control device capable of receiving an output from the vessel motion measurement device, the lift wire tension measuring device, the lift wire distance measurement device and the lift wire resonance calculation means;

~~and~~ wherein the control device ~~controlling~~controls the winch or crane system, in response to the said outputs, to payout or recover lift wire from a drum located on the vessel as required ~~according to the movement of the vessel, so as~~ to stabilise the load~~;~~.

~~wherein the apparatus further comprises at least one of:~~

~~a) a lift wire tension measuring device for measuring the tension in the lift wire;~~

~~b) a lift wire distance measurement device which measures the length of lift wire that has been paid out; and~~

~~c) a load motion measurement device for measuring the motion of the load.~~

20. (Currently amended) A heave compensation apparatus according to claim ~~1~~912, wherein the load motion measurement device comprises a motion reference unit ~~coupled to the load~~.

21. (Currently amended) A heave compensation apparatus according to claim ~~1~~912, wherein the control device comprises a control computer coupled to the drive unit for the winch or crane system.

22. (Currently amended) A heave compensation apparatus according to claim ~~1~~912, wherein the control device is operable to control, in addition to controlling the pay out and recovery of the lift wire in response to inputs from a human operator, the pay out and recovery of the lift wire in response to the output from any of the following:

a lift wire tension measuring device; and/or

a vessel motion measurement device; and/or

~~the load motion measurement device; and/or~~

a lift wire distance measurement device.

23. (Currently amended) A heave compensation apparatus according to claim ~~1~~912, wherein the control device calculates the elasticity of the lift wire from the length of wire paid out, by reference to its elasticity characteristics.

24. (Currently amended) A heave compensation apparatus according to claim ~~19~~12, wherein an effective mass of the load forms a further input to the control device, wherein the effective mass of the load comprises a mass of the load itself, an added mass, and drag loads.

25. (Cancelled)

26. (Currently amended) A method of heave compensation for a winch or crane system, the winch or crane system being provided on a vessel~~, the winch or crane system~~ and including a lift wire, the method comprising the steps of:

~~monitoring~~ measuring the motion of the vessel and inputting data indicative of the motion into a control device;

measuring the tension in the lift wire and inputting data indicative of the tension into the control device; and

measuring the length of lift wire that has been paid out and inputting data indicative of the said length into the control device; and

inputting data concerning the elasticity characteristics of the lift wire into a computational means, and further inputting data indicative of the length of lift wire that has been paid out into the computational means and using the computational means to calculate the elasticity of the lift wire and thereby provide a lift wire resonance calculation means and inputting the calculated elasticity of the lift wire into the control device; and

using the control device to control~~ling~~ the vessel winch or crane system ~~according to the movement of the vessel by adjusting the~~ in response to the said inputs, to pay out or recover~~y of the~~ lift wire from a drum located on the vessel as required to stabilise the load~~;~~.

~~and further comprising at least one of the following steps:~~

~~a) measuring he tension in the lift wire;~~

~~b) measuring the length of the lift wire that has been paid out; and~~

~~c) measuring the motion of the load.~~

27. (Cancelled)

28. (Currently amended) A method of heave compensation according to claim 26, wherein the lift wire is paid out when the movement of the load is such that the tension in the lift wire increases or is predicted by the lift wire resonance calculation means to increase, and the lift wire is recovered when the movement of the load is such that the tension in the lift wire decreases or is predicted by the lift wire resonance calculation means to decrease.

29. (New) A heave compensation apparatus according to claim 21, wherein the control computer comprises control software that utilises adaptive/predictive control techniques.

30. (New) A heave compensation apparatus according to claim 14, further comprising a lift wire resonance calculation means comprising a computational means into which an operator can input data concerning the elasticity characteristics of the lift wire, wherein the computational means takes data output from the lift wire distance measurement device and calculates the elasticity of the lift wire from the length of wire paid out, by reference to its elasticity characteristics.

31. (New) A heave compensation apparatus according to claim 13, further comprising a lift wire distance measurement device which measures the length of lift wire that has been paid out;

and wherein the load motion measurement device comprises a motion reference unit;

and further comprising a lift wire resonance calculation means comprising a computational means into which an operator can input data concerning the elasticity characteristics of the lift wire, wherein the computational means takes data output from the lift wire distance measurement device and calculates the elasticity of the lift wire from the length of wire paid out, by reference to its elasticity characteristics;

and wherein the control device is capable of receiving an output from the vessel motion measurement device, the load motion reference unit, the lift wire distance measurement device and the lift wire resonance calculation means;

wherein the control device controls the winch or crane system, in response to the said outputs, to payout or recover lift wire as required to stabilise the load.

32. (New) A heave compensation apparatus according to claim 12, wherein the apparatus further comprises a control means to permit an operator to instruct the winch or crane system to at least raise, hold or lower the lift wire and the control device is further capable of receiving an output from the operator control means and is capable of controlling the winch or crane system in response to the said outputs.

33. (New) A heave compensation apparatus according to claim 32, wherein the added mass of the load is deduced from the amount of water that is required to be moved with the load and the drag load is deduced from the drag characteristics of the load in the direction of motion thereof.

34. (New) A heave compensation apparatus according to claim 12, further comprising a rotatable member that diverts the lift wire towards the seabed wherein the rotatable member is rotatably mounted on a frame by a load pin.

35. (New) A heave compensation apparatus according to claim 34, further comprising a lift wire tension measuring device for measuring the tension in the lift wire, wherein the lift wire tension measuring device monitors the change in tension on the load pin such that changes in the tension in the lift wire are determined by monitoring the change in tension on the load pin.

36. (New) A heave compensation apparatus according to claim 35, wherein the lift wire tension measuring device is configured to measure in-line loads in the lift wire.

37. (New) A method according to claim 16, further comprising measuring the motion of the vessel and inputting data indicative of the motion into the control device.

38. (New) A method according to claim 16, further comprising measuring tension in the lift wire and inputting data indicative of the tension into the control device.

39. (New) A method according to claim 16, further comprising inputting data concerning the elasticity characteristics of the lift wire into a computational means, and further inputting data

indicative of the length of lift wire that has been paid out into the computational means and using the computational means to calculate the elasticity of the lift wire and inputting the calculated elasticity of the lift wire into the control device.

40. (New) A method according to claim 16, further comprising using the control device to control the vessel winch or crane system in response to the said inputs, to pay out or recover lift wire as required to stabilise the load.

41. (New) A method according to claim 16, wherein the lift wire is paid out when the movement of the load is such that the tension in the lift wire increases or is predicted by the lift wire resonance calculation means to increase, and the lift wire is recovered when the movement of the load is such that the tension in the lift wire decreases or is predicted by the lift wire resonance calculation means to decrease.

42. (New) A method according to claim 16, further comprising providing an output from an operator control means which indicates if an operator instructs raising, holding or lowering of the lift wire.

43. (New) A method according to claim 16, wherein an operator inputs reference data concerning the elasticity characteristics of the lift wire into the control device before commencing a lift operation.

44. (New) A method according to claim 16, wherein an operator inputs reference data concerning the mass of the load, the added mass of the load and the drag characteristics of the load into the control device before connecting a lift operation.

45. (New) A heave compensation apparatus according to claim 19, wherein the apparatus further comprises a control means to permit an operator to instruct the winch or crane system to at least raise, hold or lower the lift wire and the control device is further capable of receiving an output from the operator control means and is capable of controlling the winch or crane system in response to the said outputs.

46. (New) A heave compensation apparatus according to claim 19, wherein the control device comprises a control computer coupled to a drive unit for the winch or crane system.

47. (New) A heave compensation apparatus according to claim 19, wherein an effective mass of the load forms a further input to the control device, wherein the effective mass of the load comprises a mass of the load itself, an added mass, and drag loads.

48. (New) A heave compensation apparatus according to claim 47, wherein the added mass of the load is deduced from the amount of water that is required to be moved with the load and the drag load is deduced from the drag characteristics of the load in the direction of motion thereof.

49. (New) A heave compensation apparatus according to claim 19, further comprising a rotatable member that diverts the lift wire towards the seabed wherein the rotatable member is rotatably mounted on a frame by a load pin.

50. (New) A heave compensation apparatus according to claim 49, wherein the lift wire tension measuring device monitors the change in tension on the load pin such that changes in the tension in the lift wire are determined by monitoring the change in tension on the load pin.

51. (New) A heave compensation apparatus according to claim 49, wherein the lift wire tension measuring device is configured to measure in-line loads in the lift wire.

52. (New) A method according to either of claim 26, further comprising providing an output from an operator control means which indicates if an operator instructs raising, holding or lowering of the lift wire.

53. (New) A method according to claim 26, wherein an operator inputs reference data concerning the elasticity characteristics of the lift wire into the control device before commencing a lift operation.

54. (New) A method according to claim 26, wherein an operator inputs reference data concerning the mass of the load, the added mass of the load and the drag characteristics of the load into the control device before commencing a lift operation.